Amendments to the Claims

This listing of the claims will replace all prior versions, and listings, of claims in this application.

Claims 1–15 (canceled).

Claim 16 (currently amended): A method for preparing a composite cathode active material for a lithium secondary battery, the method comprising:

producing a first lithium metal composite oxide in a reactor by (a) precipitating a first metal composite hydroxide from a first mixture of a first metal precursor, a first aqueous ammonia solution and a first basic solution, and (b) mixing and reacting the first metal composite hydroxide with a first lithium precursor to form the first lithium metal composite oxide;

producing, separately from the first lithium metal composite oxide, a second lithium metal composite oxide by (a) precipitating a second metal composite hydroxide from a second mixture of a second metal precursor, a second aqueous ammonia solution and a second basic solution, and (b) mixing and reacting the second metal composite hydroxide with a second lithium precursor to form the second lithium metal composite oxide; and

after separately producing the first and second lithium metal composite oxides, mixing the first and second lithium metal composite oxides to form a composite cathode active material for a lithium secondary battery, wherein

the first lithium metal composite oxide has a mean particle diameter that is less than 90% of a mean particle diameter of the second lithium metal composite oxide;

<u>the first and second lithium metal composite oxides comprise a primary particle having a particle diameter distribution between about 0.1 μm and about 0.2 μm, and a secondary particle having a mean particle diameter distribution between about 1 μm and about 20 μm when the primary particles are aggregated to form the secondary particles; and</u>

the first and second lithium metal composite oxides have a formula selected from the group consisting of

$$Li_{1+\delta}[Ni_xMn_{x-y/2}Co_{1-2x-z}M_yN_z]O_{2-a}P_a$$

and

$$Li_{1+\delta}[Ni_xMn_{x+y}Co_{1-2(x+y)}M_y]O_{2-a}P_a;$$

M is selected from the group consisting of Mg, Zn, Ca, Sr, Cu and Zr;

N is selected from the group consisting of Fe, Aℓ, Ga, In, Cr, Ge and Sn;

P is selected from the group consisting of F and S;

δ has a value such that $-1/10 \leq \delta \leq 1/10$;

x has a value such that $0 \leq x \leq 1$;

y has a value such that $0 \leq y \leq 1/10$;

z has a value such that $0 \leq z \leq 1/10$; and

a has a value such that $0 \leq a \leq 0.3$.

Claim 17 (canceled).

Claim 18 (previously presented): The method of Claim 16, wherein the composite cathode active material comprises about 5 wt% to about 40 wt% of the first lithium metal composite oxide.

Claim 19 (previously presented): The method of Claim 16, wherein the first lithium metal composite oxide has the same chemical composition as the second lithium metal composite oxide.

Claim 20 (currently amended): The method of Claim 16, wherein the composite cathode active material comprises at least two <u>selected from the group consisting</u> of nickel having an oxidation value of 2.0, manganese having an oxidation value of 4.0, and cobalt having an oxidation value of 3.0.

Claim 21 (previously presented): The method of Claim 16, wherein the first and second mixtures are exposed to ultrasonic energy.

Claim 22 (previously presented): The method of Claim 16, wherein:

the first metal precursor comprises a first aqueous metal solution containing more than two metal salts; and

the second metal precursor comprises a second aqueous metal solution containing more than two metal salts.

Claim 23 (previously presented): The method of Claim 16, wherein:

the first metal precursor comprises a first aqueous metal solution containing more than two metal salts;

the first aqueous ammonia solution has a concentration that is between about 0.2 and about 0.3 times a concentration of the first aqueous metal solution;

the second metal precursor comprises a second aqueous metal solution containing more than two metal salts; and

the second aqueous ammonia solution has a concentration that is between about 0.2 and about 0.3 times a concentration of the second aqueous metal solution.

Claim 24 (previously presented): The method of Claim 16, wherein the first and second mixtures each have a pH that is between about 11.0 and about 11.5.

Claim 25 (previously presented): The method of Claim 16, further comprising exposing the first and second lithium metal composite oxides to a chelating agent, wherein the chelating agent is selected from the group consisting of citric acid, stannic acid, glycolic acid and maleic acid.

Claim 26 (previously presented): The method of Claim 16, wherein:

the first and second metal precursors have the same chemical composition;

the first and second aqueous ammonia solutions have the same chemical composition;

the first and second basic solutions have the same chemical composition; and

the first and second lithium precursors have the same chemical composition.

Claim 27 (currently amended): A method for preparing a composite cathode active material for a lithium secondary battery, the method comprising:

producing a first lithium metal composite oxide by (a) precipitating a first metal composite hydroxide from a first mixture of a first metal precursor, a first aqueous ammonia solution and a first basic solution, and (b) mixing and reacting the first metal composite hydroxide with a first lithium precursor to form the first lithium metal composite oxide;

producing a second lithium metal composite oxide by (a) precipitating a second metal composite hydroxide from a second mixture of a second metal precursor, a second aqueous ammonia solution and a second basic solution, and (b) mixing and reacting the second metal composite hydroxide with a second lithium precursor to form the second lithium metal composite oxide; and

mixing the first and second lithium metal composite oxides to form a composite cathode active material for a lithium secondary battery; wherein

the first lithium metal composite oxide has a mean particle diameter that is less than 90% of a mean particle diameter of the second lithium metal composite oxide;

<u>the first and second lithium metal composite oxides comprise a primary particle having a particle diameter distribution between about 0.1 μm and about 0.2 μm, and a secondary particle having a mean particle diameter distribution between about 1 μm and about 20 μm when the primary particles are aggregated to form the secondary particles; and</u>

the first lithium metal composite oxide has a formula

$$LiNi_{1-x'-y}Co_{x'}M'_yO_2P_z;$$

the second lithium metal composite oxide has a formula selected from the group consisting of

$$Li_{1+\delta}[Ni_xMn_{x-y/2}Co_{1-2x-z}M_yN_z]O_{2-a}P_a$$

and

$$Li_{1+\delta}[Ni_xMn_{x+y}Co_{1-2(x+y)}M_y]O_{2-a}P_a;$$

M is selected from the group consisting of Mg, Zn, Ca, Sr, Cu and Zr;

M′ is selected from the group consisting of Aℓ, Mg, Zr and Ti;

N is selected from the group consisting of Fe, Al, Ga, In, Cr, Ge and Sn;

P is selected from the group consisting of F and S;

δ has a value such that $-1/10 \leq \delta \leq 1/10$;

x has a value such that $0 \leq x \leq 1$;

x' has a value such that $x' \leq 1/10$;

y has a value such that $0 \leq y \leq 1/10$;

z has a value such that $0 \leq z \leq 1/10$; and

a has a value such that $0 \leq a \leq 0.3$.

Claim 28 (previously presented): The method of Claim 27, wherein the first and second mixtures are exposed to ultrasonic energy.

Claim 29 (currently amended): A method for preparing a composite cathode active material for a lithium secondary battery, the method comprising:

producing a first lithium metal composite oxide by (a) precipitating a first metal composite hydroxide from a first mixture of a first metal precursor, a first aqueous ammonia solution and a first basic solution, and (b) mixing and reacting the first metal composite hydroxide with a first lithium precursor to form the first lithium metal composite oxide;

producing, separately from the first lithium metal composite oxide, a second lithium metal composite oxide by (a) precipitating a second metal composite hydroxide from a second mixture of a second metal precursor, a second aqueous ammonia solution and a second basic solution, and (b) mixing and reacting the second metal composite hydroxide with a second lithium precursor to form the second lithium metal composite oxide; and

after separately producing the first and second lithium metal composite oxides, mixing the first and second lithium metal composite oxides to form a composite cathode active material for a lithium secondary battery; wherein

the first lithium metal composite oxide has a mean particle diameter that is less than 90% of a mean particle diameter of the second lithium metal composite oxide;

<u>the first and second lithium metal composite oxides comprise a primary particle having a particle diameter distribution between about 0.1 μm and about 0.2 μm, and a secondary particle having a mean particle diameter distribution between about 1 μm and about 20 μm when the primary particles are aggregated to form the secondary particles;</u>

the first and second lithium metal composite oxides have a formula selected from the group consisting of

$$Li_{1+\delta}[Ni_xMn_{x-y/2}Co_{1-2x-z}M_yN_z]O_{2-a}P_a$$

and

$$Li_{1+\delta}[Ni_xMn_{x+y}Co_{1-2(x+y)}M_y]O_{2-a}P_a;$$

M is selected from the group consisting of Mg, Zn, Ca, Sr, Cu and Zr;

N is selected from the group consisting of Fe, Aℓ, Ga, In, Cr, Ge and Sn;

P is selected from the group consisting of F and S;

δ has a value such that $-1/10 \le \delta \le 1/10$;

x has a value such that $0 \le x \le 1$;

y has a value such that $0 \le y \le 1/10$;

z has a value such that $0 \le z \le 1/10$; and

a has a value such that $0 \le a \le 0.3$.

the reactor includes an agitator having a first set of rotary vanes designed to induce fluid flow in a first direction and a second set of rotary vanes designed to induce fluid flow in a second direction that is reverse from the first direction; and

the reactor further includes a plurality of baffles that are spaced apart from an inner wall of the reactor, have a shape of a flat panel and are attached to the inner wall by a plurality of connecting rods.